Volume sources and internal jumps

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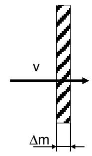
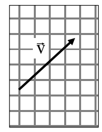
Porous layer and porous zone

Porous layer: $\Delta p = -\left(\frac{\mu}{\alpha} v + C_2 \frac{1}{2} \rho v^2 \right) \Delta m$



- Δp: pressure drop [Pa]
- Δm: thickness [m]
- α: permeability [m^2]
- C_2: inertial resistance
- v: face normal velocity component.

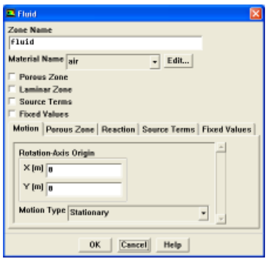
Porous zone: $F_i = -\left(\frac{\mu}{\alpha_i} v_i + C_{2,i} \frac{1}{2} \rho |v| v_i + C_0 |v|^{(C_1 - 1)} v_i \right)$



- F_i: i-th component of the volume forces in [N/m^3].

Specification of cell zone conditions in FLUENT

Cell Zone Conditions / fluid – solid / Edit



Only in fluids:

Porous Zone

Having flow resistance e.g. mat filter send bed, tube bundle, vegetation.

Laminar Zone

Locally inactivates the turbulence model. E.g. in the laminar part of the boundary layer.

Source Terms

Customized volume sources. E.g. mass, thrust (force) or heat can be introduced.

Fixed Values

Sets the value of any field variable (e.g. velocity or temperature) to a specified value.

Motion

Moving zone. Use Moving Reference Frame for frozen rotor models and Moving Mesh for sliding mesh models of rotating fluid machines.

Thermal processes

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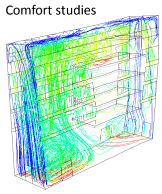
Jump conditions for internal faces

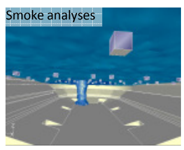
Boundary Conditions/

Interior	No jump. Fluid and heat fluxes are matched on both sides of the interior face. Default type for internal faces. Define named interiors e.g. for exact calculation of surface integrals.
Porous Jump	Internal face having flow resistance depending on the normal velocity component. E.g. a mosquito net.
Fan	$\Delta p(v)$: pressure jump of magnitude depending on the normal velocity component. Can induce swirl as well. Applications: actuation disk models of fans and mixers.
Radiator	Simple heat exchanger model resistance characteristics and the heat transfer coefficient can be specified. Temperature variation of the secondary fluid is not modeled. (The zonal heat exchanger models in FLUENT are fare more detailed.)
Wall	Internal wall. One single surface while meshing, it splits into two walls in FLUENT such as: wall1 and wall1-shadow. Helpful for meshing thin bodies.

Indoor natural convections

Comfort studies





1. Set the gravity
   E.g.: 0,0,-9.81
2. Transient simulation
   Steady usually do not converge even if a steady solution can be expected.
3. Energy equation: ON
4. Choose a temperature dependent density model
5. Set the thermal boundary conditions

Density models

Incompressible ideal gas:

$$\rho = \frac{p_0}{RT}$$

p_0: operating pressure

Boussinesq modell:

$$\rho = \rho_0 - \rho_0 \beta (T - T_0)$$

ρ_0: operating density
β: cubic heat expansion coeff.

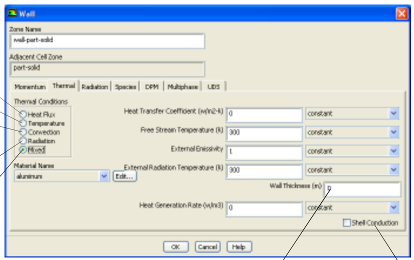
Interpretation of HTC in CFD simulations

With global reference:

$$\alpha = \frac{q}{T_w - T_{ref}}$$

T_w: wall temperature (result)
T_{ref}: reference temperature
(To be set among the Reference Values.)

Wall boundary conditions

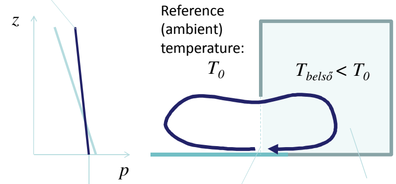


Pressure boundary conditions

If the gravity is set, a vertical pressure profile consistent with the Operating Conditions is used for reference.

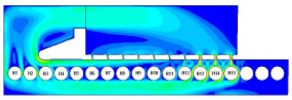
Ambient pressure:

$$p_{ref} = p_0 - \rho_0 g z, \text{ in which } \rho_0 = \frac{p_0}{R T_0}$$

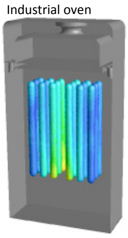


Conjugate heat transfer and thermal transients

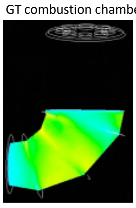
Thermal treetment



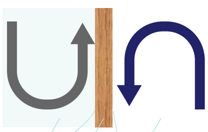
Industrial oven



GT combustion chamber



Model structure:

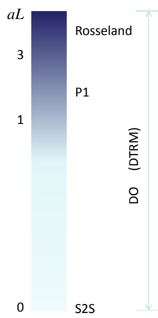


wall (coupled)
No input required.
HTC-s are computed on both sides.

Radiation heat transport

Absorption in gases: $I / I_0 = e^{-aL}$

a: attenuation coeff.
aL: optical thickness



- Rosseland, P1: fast running, because a diffusion equation is solved and the boundary facets have no direct connections.
- S2S: Boundary facets look at each other. Fluid/solid regions do not participate in the radiation process. Calculation of view factors take a while, then the iteration is fast.
- DO model. The most general approach. High computational cost. Results in unevenly distributed flux. Physical effects:
  - Optical properties depending on wave length. Non-gray radiation;
  - Semi transparent walls;
  - Spectacular and diffuse reflection.